AXIALLY LOADED BUILT-UP C-SECTION COLD-FORMED STEEL WITH HOLES

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Bachelor in Civil Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Kajian eksperimen dijalankan untuk mengkaji kelakuan keluli terbentuk sejuk terbina. Kancing binaan dalam kajian ini terdiri daripada dua bahagian C berorientasikan back-to-back membentuk suatu keratan rentas berbentuk I. Dimensi untuk spesimen diameter diameter terbahagi kepada dua iaitu 103mm dan 203mm untuk disiasat. Untuk setiap spesimen, stud disambungkan kepada satu sama lain dengan dua skru penggerudian diri yang dijarakkan pada selang yang ditetapkan. Seksyen trek keluli yang terbentuk sejuk telah bersambung dengan tegak lurus ke setiap hujung stud terbina dengan skru penggerudian sendiri melalui setiap bebibir bahagian C. Tujuan bahagian trek adalah untuk mengekalkan hujung kancing bersama dan mewakili lampiran akhir biasa. Spesimen dikimpal dengan saiz plat keluli spesifik sebelum diuji. Tujuan spesimen dikimpal adalah untuk memegang spesimen semasa ujian dan untuk mendapatkan hasil yang lebih tepat diperoleh. Keputusan spesimen boleh diperolehi oleh beban muktamad dari setiap spesimen dan untuk mengkaji tingkah laku tengkuk disebabkan oleh kedudukan pembukaan yang berbeza dalam spesimen.

ABSTRACT

An experimental investigation was conducted to study the behavior of built-up cold-formed steel. The built-up studs in this study consisted of two C-sections oriented back-to-back forming an I-shaped cross-section. The dimension for diameter built-up specimens are divided into two that are 103mm and 203mm to be investigated. For each specimen, the studs were connected to each other with two self-drilling screws spaced at a set interval. A cold-formed steel track section was connected running perpendicular to each end of the built-up stud with a single self-drilling screw through each flange of the C-sections. The purpose of the track section was to keep the ends of the studs together and represents a common end attachment. The specimens are welded with the specific size of steel plate before being testing. The purpose of welded specimen are to hold the specimens during testing and for more accurate result obtain. The result of the specimen can be obtained by the ultimate load from each specimen and to study the buckling behavior due to the different opening position in specimens.

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LIST OF ABBREVIATIONS

LBW	Lateral back
CFS	Cold-Formed steel
AISI	American Iron Steel Inside
BS	British Standard
BTB	Back-to-back
FKASA	Fakulti Kejuruteraan Alam Dan Sumber Alam
n.d	No date
LBF	Lateral torsional buckling at top support (front)
LMB	Lateral torsional buckling at middle span (front)
LTF	Lateral torsional buckling at top support (front)
DTF	Distortional buckling at top support (front)
DTB	Distortional buckling at top support (back)
DMF	Distortional buckling at middle span (front)
DBF	Distortional buckling at bottom support (front)
DBB	Distortional buckling at bottom support (back)
WMB	Warping buckling at middle span (back)
WMF	Warping buckling at middle span (front)
WBF	Warping buckling at bottom support (front)
WTB	Warping buckling at top support (back)
FE	Finite Element
SFIA	Steel Framing Industry Association
CH1	Transducer 1 – Vertical Displacement
CH2	Transducer 2 – Horizontal Displacement
CH3	Transducer 3- Horizontal Displacement

CHAPTER 1

INTRODUCTION

1.1 Introduction

Steel is one of the material of construction and is a basic ingredient needed in construction. In steel structures, there are two types of structural steel members that are hot-rolled steel members and cold-formed. The usage of cold-formed steel structures in the building construction industry is rapidly increasing due to their potential benefits including high strength to weight ratio, rapid constructability and ease of transportability than hot rolled steel. Cold-formed steel structural members are commonly provided with holes to accommodate electrical and plumbing of building.

Cold-Formed Steel (CFS) industry have improved in technology and low production cost to produce more structurally efficient and economic cross section shapes. One of the most favourable ways to perform this task is to connect two or more single members together to form a built-up section, e.g. simply connecting two channel sections back to back to form a built-up I-section. Members with built-up section can carry more load and span more distance. There are different between the built-up C-section with plain and lipped angle. These types of sections can be shown in Figures 1.1. Loading is rarely concentric due to attachments along the angles legs. For plain and lipped channel have different centroid that will affect the angles legs. Plain angles have no primary warping resistance and local-plate buckling and global torsional buckling have nearly identical deformations.

1.2 Background of Study

Opening in cold formed steel columns section (CFS) are widely used in steel frames structures to facilitate piping, electrical, mechanical and sanitary works for maintenance services and inspections. Openings also made specifically for fasteners such as bolts and screws. By considering openings in steel columns sections are to reduce the materials volume without affecting the structural strength or serviceability requirement in addition to reduce the cold bridging effect when opening channel section steel column are used in the external wall panels at cold region. The ultimate strength and elastic stiffness of a structural member can vary with opening position, size, shape and orientation. In evaluation of the section properties of members in compression, openings need to be considered. The perforations can be divided by pre-punched or punched-on-site but mostly pre-punched are more favourable due to the problem that will rise later if the holes are not accurately made.

Use of built-up cold-formed steel got several advantages. The first advantages are production and handling such as ease of production. To produce new shapes without built special production method is fastened the standard -C and Z shape by a bolt, screw, or weld. Formation of (CFS) structure can be more easier and faster without heavy lifting equipment that suitable to up to semi high building. Strength and stability are the second advantages. Higher stability and capacity for built-up section due to combination of two or more standard section that produce greater cross-section properties. The eccentricity between the shear can be devastate with the symmetry of built-up section. Built-up section with Back-To-Back (BTB) advantages to strengthening external frame column and closed built-up section used to support long beam and double storey house.

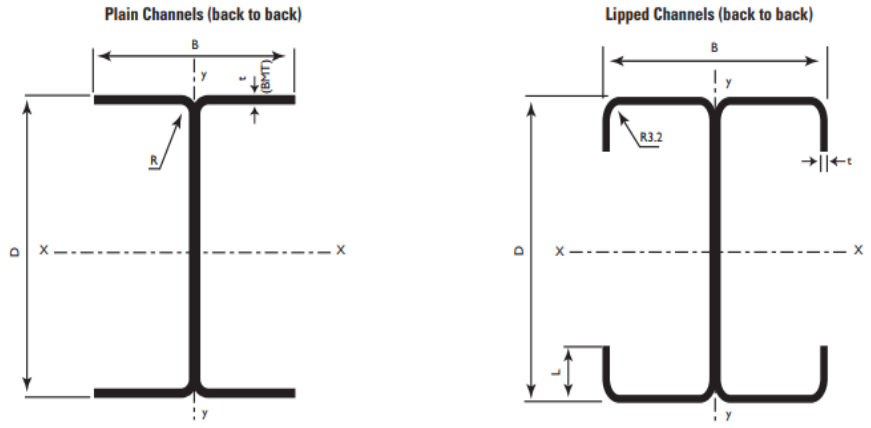

Figure 1.1 Dimension of the built-up C-section plain and lipped angles

Source: LYSAGHT (January 2010).

Table 1.1 Table of properties of plain and lipped channel with centroid position

Source: LYSAGHT (January 2010).

Plain Channels — Dimensions and Properties

Catalogue No.	Nominal Dimensions				Section Area	Mass		Second Moment of Area		Centroid
	D	B	R	t		Galv.	Black	I_x	I_y	c
	mm				mm^2	kg/m		$10^6 mm^4$		mm
LC05130	51	25	3.2	3.0	290	2.15	2.12	0.09960	0.01600	7.80
LC06425	64	23	2.5	2.5	250	2.00	1.96	0.13900	0.01110	5.88
LC07630	76	38	3.2	3.0	420	3.34	3.30	0.36400	0.57900	10.91
LC08330	83	34	3.2	3.0	420	3.34	3.30	0.41500	0.04530	9.18
LC08930	89	31	3.2	3.0	420	3.34	3.30	0.45700	0.03560	7.84
LC09530	95	37	3.2	3.0	465	3.70	3.65	0.59300	0.05340	9.09
LC10330	103	34	3.2	3.0	465	3.70	3.65	0.66100	0.03890	7.42
LC10230	102	55	3.2	3.0	600	4.78	4.71	0.98400	0.18080	15.67
LC12730	127	50	3.2	3.0	660	5.26	5.18	1.58200	0.17050	13.22
LC15230	152	51	3.2	3.0	735	5.86	5.77	2.42000	0.17970	12.02

Lipped Channels — Dimensions and Properties of Full Unreduced Sections

Catalogue No.	Nominal Dimensions				Section Area	Mass		Second Moment of Area		Centroid
	D	B	L	t		Galv.	Black	I_x	I_y	c
	mm				mm^2	kg/m		$10^4 mm^4$		mm
LL06425	64	38	13	2.5	363	2.90	2.85	0.2280	0.0680	14.2
LL07610	76	44	11	1.0	175	1.43	1.37	0.1682	0.0464	15.3
LL07625	76	44	16	2.5	438	3.49	3.44	0.3920	0.1156	15.7
LL10225	102	51	18	2.5	550	4.39	4.32	0.8870	0.1980	18.2
LL10230	102	51	19	3.0	660	5.25	5.18	1.0450	0.2370	18.6
LL12725	127	51	18	2.5	612	4.89	4.81	1.4870	0.2140	16.5
LL12730	127	51	19	3.0	735	5.85	5.77	1.7600	0.2570	16.9
LL15230	152	64	21	3.0	900	7.16	7.07	3.1800	0.4980	20.9
LL20330	203	76	24	3.0	1140	9.07	8.95	7.1150	0.8750	23.1

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